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CFRP REPAIR OF IMPACT-DAMAGED BRIDGE GIRDERS

VOLUME II – INSPECTION OF FRP COMPOSITE REPAIRS USING INFRARED THERMOGRAPHY

PROBLEM STATEMENT

The Florida Department of Transportation (FDOT) currently uses fiber-reinforced polymer (FRP) composites to repair prestressed concrete bridges that have been damaged by vehicle impact. The Chaffee Road Bridge over Interstate 10 in Jacksonville is an excellent example of a bridge on which this type of repair has been used. This bridge was severely damaged by an over height vehicle on July 6, 2001, and FRP composites were used successfully in an emergency repair of the bridge. At that time, however, FDOT had limited or no experience with many of the FRP systems manufacturers that were used to perform this type of emergency repair.

OBJECTIVES

The FDOT Structures Research Lab tested six Type II AASHTO girders, strengthened with FRP, to determine the post-repair behavior and capacity. There were two primary objectives of this research: (1) evaluate and report the behavior of the FRP repair systems during the load test (cf. Volume I), and (2) use infrared thermography (IRT) to inspect the FRP composites before, during and after the load tests (cf. Volume II). Infrared thermography is a non-contact remote sensing technique that can be used to determine if FRP systems are properly bonded to the concrete substrate.

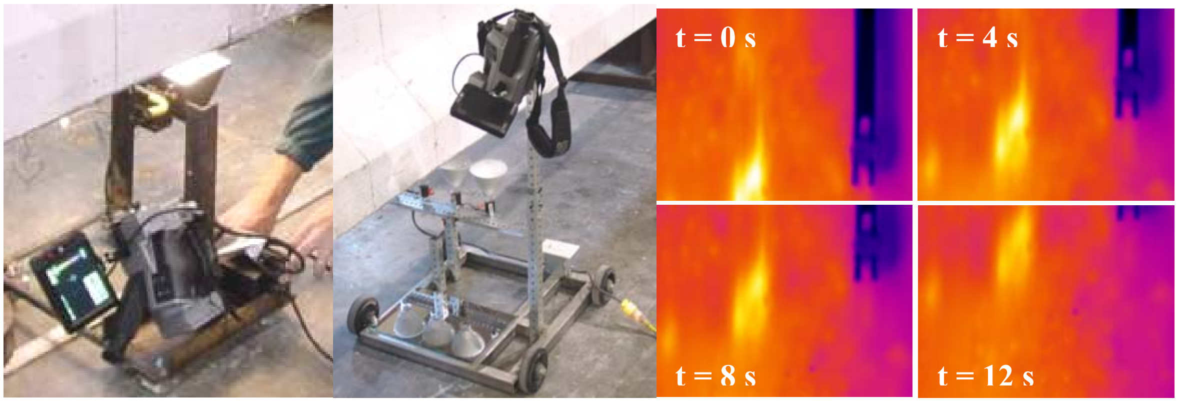
FINDINGS AND CONCLUSIONS

The IR thermography research was divided into two phases:

1. **Phase 1 –** Perform IRT on full-scale AASHTO girders strengthened with FRP and loaded to failure in the laboratory (cf. Volume I for a description of load tests/results).
2. **Phase 2 –** Perform IRT on an in-service girder (the ChaffeeRd./I-10 overpass) strengthened with FRP.

Phase 1

Laboratory results indicated that IRT is a potentially powerful tool for identifying unbonded areas in FRP systems (figure 1). However, as the thickness of the FRP system increases, detection of unbonded areas at the FRP/concrete interface becomes increasingly difficult. IRT was not successful in detecting defects at the FRP/concrete interface in the systems applied to girder 3, 4, or 5. Near surface defects, however, were detected in all of these systems. IRT was capable of detecting defects throughout the thickness of the composite applied to girder 6.

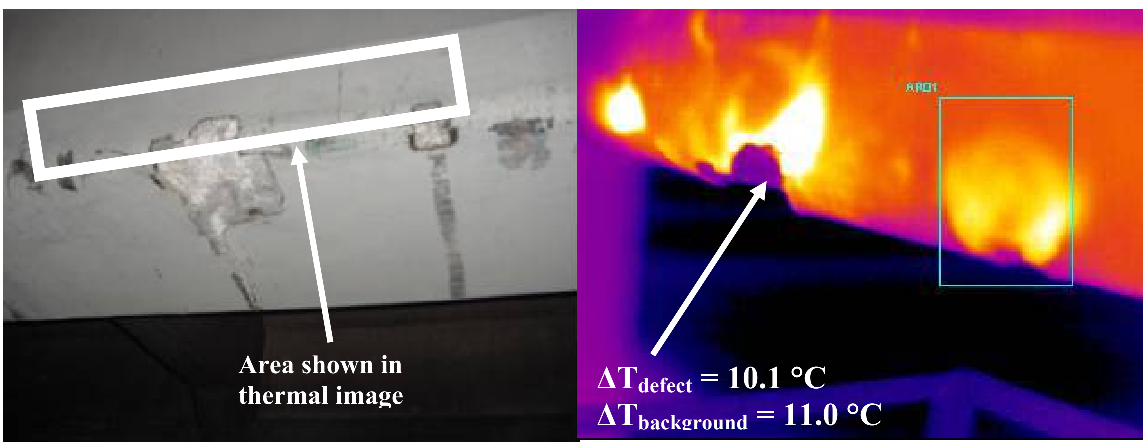


(a) (b) (c)

Figure 1: Data collection in laboratory (a) and (b) scanning cart configurations and (c) typical thermal images

Phase 2

The IRT inspections performed on the in-service bridge identified several installation defects (figure 2). Researchers also inspected a portion of one girder with additional impact damage to the FRP system. Thermography results indicated that the detected damage was limited to the vicinity of the impact. Further research is needed to (1) improve data collection efficiency and (2) develop a standardized inspection procedure that can be used for a wide variety of FRP system types.



(a) (b)

Figure 2: Field inspection of Chaffee Rd. Bridge (a) visible impact damage to FRP system (b) thermal image

BENEFITS

Qualitative IRT has been touted as an alternative inspection method for bonded FRP composites on concrete. Results from this research indicate that qualitative IRT with step-heating works well for detecting near surface defects. As the thickness of the FRP system increases, however, detecting unbonded areas at the FRP/concrete interface becomes more difficult. Therefore, qualitative step-heating IRT methods will usually only be successful on single-layer systems or in detecting near-surface delaminations in multi-layer systems. To that extent, then, it offers an inspection method on repairs that are difficult to inspect.

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